

CLAIMS:

1. A method of establishing wireless communications between an interrogator and individual ones of multiple wireless identification devices, the method comprising utilizing a tree search method to attempt to identify individual ones of the multiple wireless identification devices so as to be able to perform communications, without collision, between the interrogator and individual ones of the multiple wireless identification devices, a search tree being defined for the tree search method, the tree having multiple nodes respectively representing subgroups of the multiple wireless identification devices, wherein the interrogator transmits a command at a node, requesting that devices within the subgroup represented by the node respond, wherein the interrogator determines if a collision occurs in response to the command and, if not, repeats the command at the same node.

2. A method in accordance with claim 1 wherein, if a collision occurs in response to the first mentioned command, the interrogator sends an command at a different node.

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1 3. A method in accordance with claim 1 wherein a subgroup contains
2 both a device that is within communications range of the interrogator, and a
3 device that is not within communications range of the interrogator, and wherein
4 the device that is not within communications range of the interrogator does not
5 respond to the command.

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7 4. A method in accordance with claim 1 wherein a subgroup contains
8 both a device that is within communications range of the interrogator, and a
9 device that is not within communications range of the interrogator, and wherein
10 the device that is within communications range of the interrogator responds to
11 the command.

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13 5. A method in accordance with claim 1 wherein a device in a
14 subgroup changes between being within communications range of the interrogator
15 and not being within communications range, over time.

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17 6. A method in accordance with claim 1 wherein the wireless
18 identification device comprises an integrated circuit including a receiver, a
19 modulator, and a microprocessor in communication with the receiver and
20 modulator.
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1 7. A method of addressing messages from an interrogator to a
2 selected one or more of a number of communications devices, the method
3 comprising:

4 establishing a first predetermined number of bits to be used as unique
5 identification numbers, and establishing for respective devices unique
6 identification numbers respectively having the first predetermined number of bits;

7 establishing a second predetermined number of bits to be used for
8 random values;

9 causing the devices to select random values, wherein respective devices
10 choose random values independently of random values selected by the other
11 devices;

12 interrogator transmitting a command from the interrogator requesting
13 devices having random values within a first specified group of random values
14 to respond;

15 receiving the command at multiple devices, devices receiving the
16 command respectively determining if the random value chosen by the device
17 falls within the first specified group and, if so, sending a reply to the
18 interrogator; and

19 determining using the interrogator if a collision occurred between devices
20 that sent a reply and, if so, creating a second specified group smaller than the
21 first specified group; and, if not, again transmitting a command requesting
22 devices having random values within the first specified group of random values
23 to respond.

1 8. A method of addressing messages from an interrogator to a
2 selected one or more of a number of communications devices in accordance
3 with claim 7 wherein sending a reply to the interrogator comprises transmitting
4 the unique identification number of the device sending the reply.
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6 9. A method in accordance with claim 7 wherein one of the first and
7 second specified groups contains both a device that is within communications
8 range of the interrogator, and a device that is not within communications range
9 of the interrogator, and wherein the device that is not within communications
10 range of the interrogator does not respond to the interrogator.
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12 10. A method of addressing messages from an interrogator to a
13 selected one or more of a number of communications devices in accordance
14 with claim 7 wherein, after receiving a reply without collision from a device,
15 the interrogator sends a command individually addressed to that device.
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1 11. A method of addressing messages from an interrogator to a
2 selected one or more of a number of communications devices, the method
3 comprising:

4 establishing unique identification numbers for respective devices;

5 causing the devices to select random values, wherein respective devices
6 choose random values independently of random values selected by the other
7 devices;

8 transmitting an Identify command from the interrogator requesting devices
9 having random values within a specified group of a plurality of possible groups
10 of random values to respond, the plurality of possible groups being organized
11 in a binary tree defined by a plurality of nodes at respective levels, the
12 specified group being defined as being at one of the nodes, wherein the size
13 of groups of random values decrease in size by half with each node descended;

14 receiving the command at multiple devices, devices receiving the
15 command respectively determining if the random value chosen by the device
16 falls within the specified group and, if so, sending a reply to the interrogator;
17 and, if not, not sending a reply; and

18 determining using the interrogator if a collision occurred between devices
19 that sent a reply and, if so, creating a new, smaller, specified group by
20 descending in the tree; and, if not, transmitting an Identify at the same node.
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1 12. A method of addressing messages from an interrogator to a
2 selected one or more of a number of communications devices in accordance
3 with claim 11 wherein establishing unique identification numbers for respective
4 devices comprises establishing a predetermined number of bits to be used for
5 the unique identification numbers.

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7 13. A method of addressing messages from an interrogator to a
8 selected one or more of a number of communications devices in accordance
9 with claim 12 and further including establishing a predetermined number of bits
10 to be used for the random values.
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1 14. A method of addressing messages from an interrogator to a
2 selected one or more of a number of RFID devices, the method comprising:
3 establishing for respective devices unique identification numbers
4 respectively having a first predetermined number of bits;
5 establishing a second predetermined number of bits to be used for
6 random values;
7 causing the devices to select random values, wherein respective devices
8 choose random values independently of random values selected by the other
9 devices;
10 transmitting a command using the interrogator requesting devices having
11 random values within a specified group of a plurality of possible groups of
12 random values to respond, the specified group being equal to or less than the
13 entire set of random values, the plurality of possible groups being organized
14 in a binary tree defined by a plurality of nodes at respective levels, wherein
15 the maximum size of groups of random values decrease in size by half with
16 each node descended;
17 receiving the command at multiple devices, devices receiving the
18 command respectively determining if their chosen random values fall within the
19 specified group and, only if so, sending a reply to the interrogator, wherein
20 sending a reply to the interrogator comprises transmitting the unique
21 identification number of the device sending the reply;
22 determining using the interrogator if a collision occurred between devices
23 that sent a reply and, if so, creating a new, smaller, specified group using a

level of the tree different from the level used in the interrogator transmitting, the interrogator transmitting a command requesting devices having random values within the new specified group of random values to respond; and, if not, the interrogator re-transmitting a command requesting devices having random values within the first mentioned specified group of random values to respond; and

if a reply without collision is received from a device, the interrogator subsequently sending a command individually addressed to that device.

15. A method of addressing messages from an interrogator to a selected one or more of a number of RFID devices in accordance with claim 14 wherein the first mentioned specified group contains both a device that is within communications range of the interrogator, and a device that is not within communications range of the interrogator, and wherein the device that is not within communications range of the interrogator does not respond to the transmitting of the command or the re-transmitting of the command.

1 16. A method of addressing messages from an interrogator to a
2 selected one or more of a number of RFID devices in accordance with claim
3 14 wherein the first mentioned specified group contains both a device that is
4 within communications range of the interrogator, and a device that is not within
5 communications range of the interrogator, and wherein the device that is within
6 communications range of the interrogator responds to the transmitting of the
7 command and the re-transmitting of the command.

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9 17. A method of addressing messages from an interrogator to a
10 selected one or more of a number of RFID devices in accordance with claim
11 14 wherein a device in the first mentioned specified group is capable of
12 changing between being within communications range of the interrogator and not
13 being within communications range of the interrogator over time.

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15 18. A method of addressing messages from an interrogator to a
16 selected one or more of a number of RFID devices in accordance with
17 claim 14 wherein the devices respectively comprise an integrated circuit
18 including a receiver, a modulator, and a microprocessor in communication with
19 the receiver and modulator.
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1 19. A method of addressing messages from an interrogator to a
2 selected one or more of a number of RFID devices in accordance with
3 claim 14 and further comprising, after the interrogator transmits a command
4 requesting devices having random values within the new specified group of
5 random values to respond:

6 devices receiving the command respectively determining if their chosen
7 random values fall within the new smaller specified group and, if so, sending
8 a reply to the interrogator.

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10 20. A method of addressing messages from an interrogator to a
11 selected one or more of a number of RFID devices in accordance with
12 claim 19 and further comprising, after the interrogator transmits a command
13 requesting devices having random values within the new specified group of
14 random values to respond:

15 determining if a collision occurred between devices that sent a reply and,
16 if so, creating a new specified group and repeating the transmitting of the
17 command requesting devices having random values within a specified group of
18 random values to respond using different specified groups until all of the
19 devices capable of communicating with the interrogator are identified.
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21. A communications system comprising an interrogator, and a plurality of wireless identification devices configured to communicate with the interrogator in a wireless fashion, the interrogator being configured to employ tree searching to attempt to identify individual ones of the multiple wireless identification devices, so as to be able to perform communications without collision, between the interrogator and individual ones of the multiple wireless identification devices, the interrogator being configured to follow a search tree, the tree having multiple nodes respectively representing subgroups of the multiple wireless identification devices, the interrogator being configured to transmit a command at a node, requesting that devices within the subgroup represented by the node respond, the interrogator further being configured to determine if a collision occurs in response to the command and, if not, to repeat the command at the same node.

22. A communications system in accordance with claim 21 wherein the interrogator is configured to send a command at a different node if a collision occurs in response to the first mentioned command.

23. A communications system in accordance with claim 21 wherein a subgroup contains both a device that is within communications range of the interrogator, and a device that is not within communications range of the interrogator.

1 24. A communications system in accordance with claim 21 wherein a
2 subgroup contains both a device that is within communications range of the
3 interrogator, and a device that is not within communications range of the
4 interrogator, and wherein the device that is within communications range of the
5 interrogator responds to the command.

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7 25. A communications system in accordance with claim 21 wherein a
8 device in a subgroup is movable relative to the interrogator so as to be capable
9 of changing between being within communications range of the interrogator and
10 not being within communications range.

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12 26. A communications system in accordance with claim 21 wherein the
13 wireless identification device comprises an integrated circuit including a receiver,
14 a modulator, and a microprocessor in communication with the receiver and
15 modulator.
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1 27. A system comprising:
2 an interrogator;
3 a number of communications devices capable of wireless communications
4 with the interrogator;
5 means for establishing a first predetermined number of bits to be used
6 as unique identification numbers, and for establishing for respective devices
7 unique identification numbers respectively having the first predetermined number
8 of bits;
9 means for establishing a second predetermined number of bits to be used
10 for random values;
11 means for causing the devices to select random values, wherein respective
12 devices choose random values independently of random values selected by the
13 other devices;
14 means for causing the interrogator to transmit a command requesting
15 devices having random values within a specified group of random values to
16 respond;
17 means for causing devices receiving the command to determine if their
18 chosen random values fall within the specified group and, if so, send a reply
19 to the interrogator; and
20 means for causing the interrogator to determine if a collision occurred
21 between devices that sent a reply and, if so, create a new, smaller, specified
22 group; and, if not, transmit a command requesting devices having random
23 values within the same specified group of random values to respond.

1 28. A system in accordance with claim 27 wherein sending a reply to
2 the interrogator comprises transmitting the unique identification number of the
3 device sending the reply.

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5 29. A system in accordance with claim 27 wherein a specified group
6 contains both a device that is within communications range of the interrogator,
7 and a device that is not within communications range of the interrogator.

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9 30. A system in accordance with claim 27 wherein the interrogator
10 further includes means for, after receiving a reply without collision from a
11 device, sending a command individually addressed to that device.
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1 specified group of random values to respond; and, if not, the interrogator being
2 configured to re-transmit a command requesting devices having random values
3 within the first mentioned specified group of random values to respond; and

4 if a reply without collision is received from a device, the interrogator
5 being configured to send a command individually addressed to that device.
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7 32. A system in accordance with claim 31 wherein the first mentioned
8 specified group contains both a device that is within communications range of
9 the interrogator, and a device that is not within communications range of the
10 interrogator.
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12 33. A system in accordance with claim 31 wherein a device in the
13 first mentioned specified group is capable of changing between being within
14 communications range of the interrogator and not being within communications
15 range of the interrogator over time.
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17 34. A system in accordance with claim 31 wherein the respective
18 devices comprise an integrated circuit including a receiver, a modulator, and
19 a microprocessor in communication with the receiver and modulator.
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the interrogator determining if a collision occurred between devices that sent a reply and, if so, creating a new, smaller, specified group by descending in the tree; and, if not, transmitting an Identify command at the same node.

1 36. A system in accordance with claim 35 wherein the unique
2 identification numbers for respective devices are stored in digital form and
3 respectively comprise a predetermined number of bits.

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5 37. A system in accordance with claim 35 wherein the random values
6 for respective devices are stored in digital form and respectively comprise a
7 predetermined number of bits.

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9 38. A system in accordance with claim 35 wherein the interrogator is
10 configured to determine if a collision occurred between devices that sent a reply
11 in response to respective Identify commands and, if so, to create further new
12 specified groups and repeat the transmitting of the Identify command requesting
13 devices having random values within a specified group of random values to
14 respond using different specified groups until all responding devices capable of
15 responding are identified.
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